THE

USE AND CARE OF A BALANCE

PETER J. KRAYER

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BY

oseph
PETER J. KRAYER

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CONTENTS.

The Use and Care of a Balance.

A METHOD OF WEIGHING.

For accurate weighting it is customary to make a Balance oscillate four or five divisions on each side of the zero point. To do this the weigher is obliged to force an oscillation, by means of pushing in the pan arrest two or three times, or as often as necessary to create the necessary oscillation. As the rider is usually in use on the Beam it cannot be used for that purpose. With a container, such as a crucible or bulb that is first weighed, then charged and then weighed again, it is best on the first weighing to add, say one milligram by moving the rider, or make the balance swing out to the left five divisions and back to the zero point. On the second weighing do the same thing making it swing out to five divisions and back to the zero point. The weighing will be correct as the extra weight will be added to the crucible or bulb and not to the object weighed.

SETTING UP A BALANCE.

When a balance has been unpacked and is ready for setting up, clean the balance case, pillar, beam and stirrups. Screw the index tightly upon the beam, using a pin on indexes having a hole drilled in the upper part for

that purpose, until the screw on the little adjusting weight upon the index is directly in front. Then place the beam into its position by placing the socket on the beam onto the ball on the beam support, at the same time lowering the beam supports about half way. Then swing the beam on the socket until the bearing on the other side comes directly over the point. Raise the beam support and bring the beam into its proper position.

The stirrups are marked with one dot (′) or two dots (″), as are the beam supports. They should be placed upon their supports according to these marks. Care should be taken that all marks come to the front. The bow wires or pans are marked (′) or (″), or the pans are stamped "L" or "R" for left and right respectively. In placing the pans upon the hooks of the stirrups care should be taken at all times to have the marks to the front, or the letters so that they can be read correctly from the front.

This point may seem insignificant, but as a matter of fact it is very important. When bows are placed upon the balance with the marks to the rear or the letters in a position to be read backwards they are not the same position in which they were when the balance was finally adjusted by the manufacturer. This reversal of the bows from their correct positions, often throws them out of

adjustment with the pan arrests, causing the index to go to one side of the zero point.

It must be assumed that the balance has been perfectly adjusted before leaving the factory and that every part has been placed in its proper position. The index should be firmly screwed upon the beam, and the screw head of the sliding weight on the index should be facing the front. If the balance has been correctly adjusted by the manufacturer, the sliding weight will naturally go into its proper position upon the index being screwed tightly into the beam. If, however, when the index is screwed tightly into the beam, the sliding weight does not face properly, the weight should be turned so as to bring the screw head to the front. Be careful not to raise or lower the weight while doing so.

TEMPERATURE.

The place for setting up a balance must be carefully selected and pains must be taken to insure uniform temperature throughout. Do not allow the heat from a radiator to strike the beam from one side. The heat from any artificial heater, or even the sun, when reflected more upon one end of the beam than on the other will cause a greater expansion of the nearer end of the beam, thus throwing the balance out of equilibrium, by changing the arm length.

The importance of temperature may be illustrated by the following experiment:

Take two brass weights of about 10 grams each. Place the weights in the balance, allowing them to remain there for about one half hour, in order that they may acquire throughout the same temperature as that of the interior of the balance. Place one on each scale pan and balance them with the rider. Then with a pair of forceps take one weight out of the balance, placing it in the palm of the hand and closing the fingers over it. Hold it in this manner for about a minute. Then replace it upon the scale pan. Note that they do not now balance. To complete the experiment and to fully appreciate the absolute necessity for uniform temperature for exact weighing, leave the rider in its position on the beam. Allow the weight thrown off by the change in temperature to remain on the balance pan, and from time to time test it, and note the length of time required for it to again regain the temperature, as nearly as possible, of the original weighing. When the weights balance, or almost balance, it shows that the weight experimented with has almost regained the temperature of the first weighing.

There are very few balances that will not change arm length with a change in temperature. The arm length of a balance can often be regulated with the temperature

in the room; that is, the arm length of a balance adjusted to a temperature of 85 degrees may not be equal in a temperature of 75 degrees, but by raising the temperature to 85 degrees it will be found to be correct.

TESTING A BALANCE FOR ZERO POINT.

After a balance has been set up according to directions, and time has been allowed for temperature, the balance should be carefully released. A perfectly adjusted balance will not oscillate; but, all conditions being perfect, the index will remain stationary at the zero point.

To obtain an oscillation of the index, place the rider upon the beam at the two milligram division, picking up the rider as soon as the beam is brought into motion. This will create the desired swing or oscillation. Five divisions on the index plate are generally obtained. Take five oscillations in the usual way to obtain the equilibrium, or zero point.

ARM LENGTH.

The distance on the beam, between the bearing point of the center knife-edge and the bearing point of the right end knife-edge is the right arm length. The distance between the bearing point of the center knife-edge and the bearing point of the left end knife-edge is the left arm length.

TESTING A BALANCE FOR ARM LENGTH.

First: Place the rider upon the one milligram division, and see how many divisions it will indicate on the index plate. It should swing to five and back again to zero.

Then place fifty grms. upon each pan. If the weights are of equal value, the zero point will be retained as at first, provided, however, that the arm length of the beam and the line of the knife edges are perfect. Then again place the rider upon the one milligram division, with the 50 grams still upon the pan. The index should show five divisions on the index plate to be perfect.

When a balance, upon testing with fifty grms. in each pan, swings for instance, five divisions to the right, and by changing the weights (that is, the weight from the right hand pan to the left hand pan, and that from the left hand pan to the right,) the balance still shows five divisions to the right, the weights are of equal value, but the arm length of the balance is out five divisions, the left arm being longer than the right, so that if the sensibility of the balance was found to be five divisions to one milligram, the balance is out one milligram on each weighing.

When a balance, upon testing with 50 grams in each pan, swings, say five divisions to the right and back to the zero point, and by changing the weights from left to

right and from right to left, it swings five divisions to the left, the weights are out and the arm lengths of the balance are equal.

But if it swings five divisions to the right and three divisions to the left, both balance and weights are inaccurate. That is, the weights are off three divisions plus one-half the difference between five divisions and three divisions, or two divisions, which is one division. Three plus one equals ($3 + 1 = 4$) four divisions for the weight, and one division for the arm length of the beam.

TESTING FOR SENSIBILITY.

When a balance, on testing for sensibility, shows five divisions for one milligram without weight, and reduces in sensibility with 50 grams in each pan it is due to either of two causes. First, the beam is not constructed strongly enough to bear the weight; or, second, the center knife-edge is above the end ones, thus, as in Fig. 1, caused by the knife-edges being worn, or improperly adjusted. If the sensibility should increase, then the knife-edges are as in Fig. 2, that is, the center knife-edge is lower than the end ones. In either case the sensibility cannot be made uniform by the adjusting weight upon the index.

If the sensibility, with and without weights, remains

the same, then the knife-edges are as in Fig. 3, that is, they are in a perfect line.

If the knife-edges are found to be as in Figs. 1 and 2, the sensibility cannot be regulated by the weight for that purpose on the index. In Fig. 1, the more weight placed

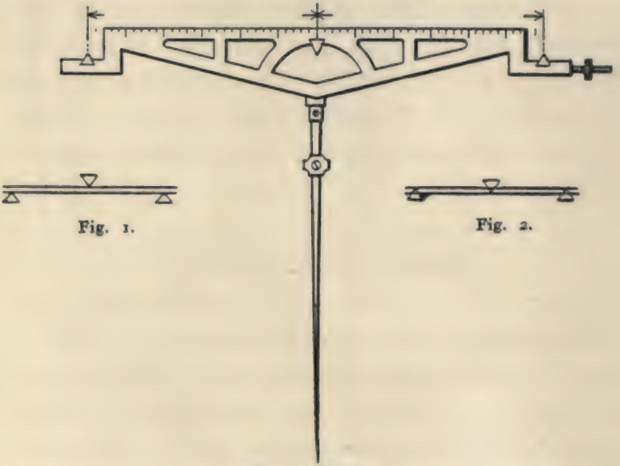

Fig. 1.

Fig. 2.

Fig. 3.—Beam.

upon the pans, the less sensitive it becomes; in Fig. 2, with each addition of weight in the pans, the sensibility increases up to the point where the beam begins to bend; it will then gradually decrease, and continue to decrease as weight is added.

In Fig. 3, however, the sensitiveness can be regulated at

any desired sensitiveness, five or ten divisions upon the index plate for one milligram, and will remain so up to the point where the beam begins to bend. When this point is reached care should be taken not to exceed this weight, for it will injure the balance if too frequently done.

If a balance, when tested, is found as in Fig 3, the latter, after being in use for some time, it is found as in Fig. 1, the knife-edges have become worn, and must be sharpened and brought back to their former position.

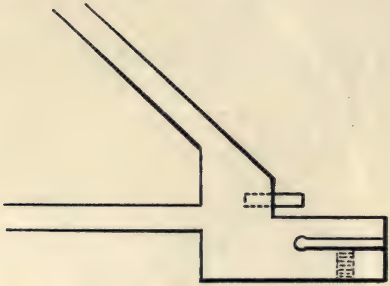

Fig. 4.

Figs. 4, 5 and 6 show three views of the Sartorius beam. Fig. 4, shows the front view of the end of the beam, without the knife-edge. Fig. 5 shows end view of beam with knife-edge upon it. Fig. 6, shows front view of end of beam with knife-edge upon it.

By viewing Fig. 4, it will be seen that the ends thereof are slit, thus having two parts. It will be seen further

that a hole is drilled through the lower part. This hole is partly threaded and a steel pin is inserted into it; a screw is then screwed in forcing the pin up against the

Fig. 5.

under side of the top of the beam. Often when removing this screw, the pin drops out and is lost, causing much annoyance.

In Fig. 6, two screws will be observed, marked "A";

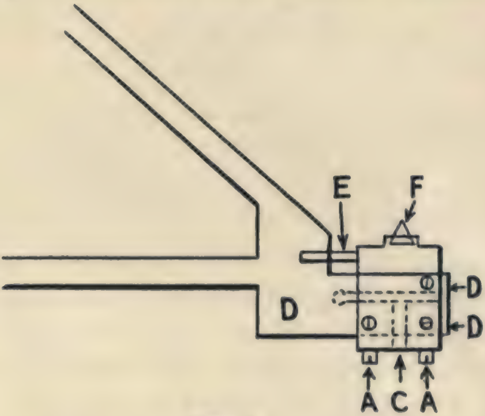

Fig. 6.

three screws marked "D"; one screw marked "C" and one marked "E."

If, when testing a balance, the knife-edges are found as in Fig. 1 loosen two screws (Fig. 6) marked "A," and three screws "D" and fasten screw "C" so as to force the steel pin up against the under side of the top of the beam, thus forcing the latter up in turn. Then fasten two screws "A" until the knife-edges are found as in Fig. 3.

The arm length is adjusted by the screw "E" upon the side found to be the shortest, by unscrewing the screw "E" until the arm length is found to be equal.

Some Sartorius balances have a sliding weight upon the index, others have a sliding weight upon the beam and still another kind has a screw extending up and down between two upright parts of the beam in the center, for the purpose of adjusting the sensibilities.

The following rules for adjusting for sensibility in these balance are applicable only in the last two cases: To raise the sensibility, raise the sliding weight or screw (in the last mentioned case, screw) on the beam for that purpose, upward. To lower the sensibility, lower the sliding weight, or screw downward the screw on the beam for that purpose.

On balances having the sliding weight on the index the adjustment for sensibility is made in the same manner as on other balances; that is, to raise the sensibility, raise the weight and to lower it, lower the weight.

THE RIDER.

The graduation on the beam has for its object the doing away with small weights below five or ten milligrams. Therefore, to determine the weight of the rider required on the balance it is well to know that the distance between the center knife-edge and the end knife-

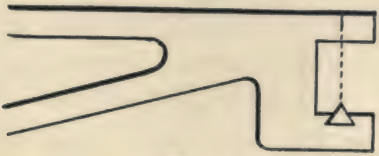

Fig. 7.

edge is divided into a given number of parts, usually five or six, and ten or twelve; each of these subdivided into five or ten parts.

Some beams have an extension over the end knife-edge, as in Fig. 7, while others have not, as in Fig. 8. In the

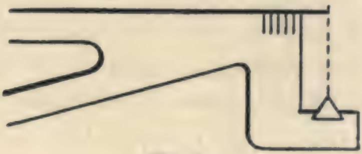

Fig. 8.

case of Fig. 7, the rider may be placed directly over the knife-edge and the beam may be divided into five or ten parts, the rider weighing five or ten milligram, corresponding with a five or ten milligram weight in the opposite pan. Thus each part corresponds to one milligram.

In the case of Fig. 8, however, the beam must be divided into six or twelve parts, so that the rider weighing six or twelve milligrams when placed upon the five or

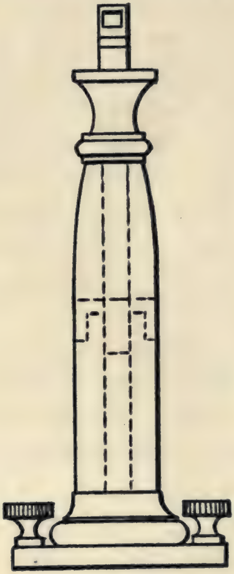

Fig. 9.—Pillar.

ten division will correspond with a five or ten milligram weight in the opposite pan; so that, while the number five or ten may be the largest stamped on the beam, that does not signify the weight of the rider required.

The rider is carried along on the beam by a hook upon

a rod called the rider-rod. This rider-rod should run parallel with the beam.

Very often the thumb screws that fasten the stand or pillar to the case become loosened and allow the pillar to turn, so that the beam is no longer parallel with the rider-rod. This may occur in shipment or later, the shrinking of the wood in the case; or the washers (some having washers between the metal nuts and the glass plates), causing the riders to be thrown from the beam. To correct this error turn the pillar so that the beam is again brought parallel with the rider-rod and fasten the pillar to the case by the two thumb screws marked "A" in Fig. 9.

IMPROPERLY ADJUSTED BALANCES, HOW TO ADJUST THEM.

Note 1.—When a beam is supported the center knife-edge should be free, so that day light can be seen between the knife-edge and the plane. The same should be observed in the end knife-edges, between the knife-edges and the stirrup planes. When the center knife-edge rests upon the center plane, that is the beam supports, Fig. 10, do not raise the beam sufficiently to see daylight between the center knife-edge and the plane, while daylight can be seen between the end knife-edges and the stirrup planes, (the thumb screws "A," Fig. 9, being firmly fastened); then the beam must be raised by means of

the screws "A," "A" in the Beam Support, Fig. 10, until

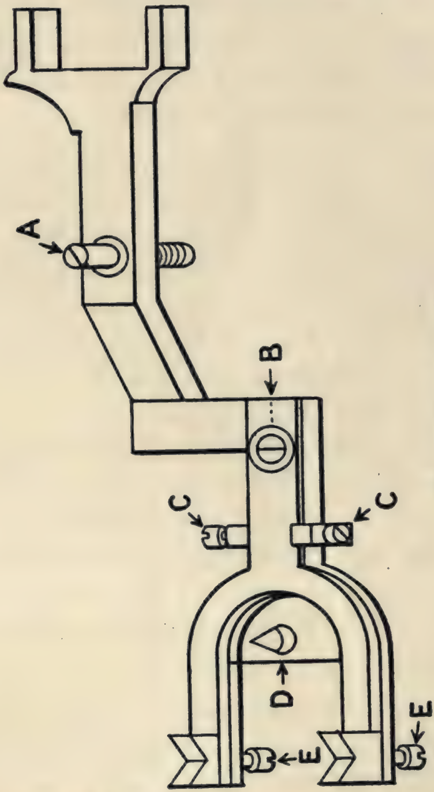

Fig. 10.—Beam support.

daylight can be seen between the center knife-edge and the plane.

In so doing always observe the index, keeping the point at the zero point on the index plate. Sometimes the screws "A," Fig. 10 become loosened and by so doing lower the beam supports, and the beam can be raised to its proper position by fastening them.

Note 2.—When, on releasing the beam the index deviates to the right or left, and back to the zero point, before releasing the pan rests, it is an indication that one stirrup is raised more from the knife-edge than the other, If the index deviates to the left, then the left hand stirrup is raised more from the knife-edge than the right. If the stirrup support is raised from Fig. 10, the left hand stirrup should be lowered by means of the screws "E," "E" (Fig. 10) until the index does not deviate but remains perfectly stationary at the zero point. If it is found that the stirrup support rests firmly upon Fig. 10 on the left hand side, then the right hand stirrup must be raised by means of the screws "E," "E" on the right hand side, until the index does not deviate, but remains perfectly stationary at the zero point.

Note 3.—When the index deviates to the right and back again to the zero point, then the right hand stirrup is raised more from the knife-edge than the left. If the stirrup support is raised from Fig. 10 on the right hand side, the right stirrup should be lowered by means

of the screws "E," "E" (Fig. 10) on the right hand side, until the index does not deviate from the zero point (or the stirrup support rests upon Fig. 7). If, when the stirrup support rests upon Fig. 10, the index still deviates to the right, it is adjusted by raising the stirrup support by means of the screws "E," "E" Fig. 10, on the left hand side, until the index does not deviate but remains perfectly stationary at the zero point.

Note 4.—When the beam is arrested and the index does not point to the zero point on the index plate, the index not having been bent by accident, it is caused by the loosening of screw "D," Fig. 10. In this case, if the index points to the left it will be found that the right hand stirrup is raised more from the knife-edge than the left, and the center knife-edge rests upon the plane, screw "D" on the right hand side of Fig. 10 should be raised until daylight can be seen between the knife-edge and the plane, when the index points to the zero point. If, when the index is brought to the zero point, and the stirrups are in proper position, and the center is still not brought into its proper position, further adjustment must be made by the screws "A," "A," Fig. 10, until daylight can be seen between the center knife-edge and the plane.

Note 5.—When the index, upon arresting the beam, deviates back towards the index plate, it will be found

that the end knife-edges and the stirrup planes are not parallel. On balances not having adjustment upon the beams, as in Fig. 11, it will be seen that the planes, upon either the right or left hand stirrup or both strike the knife-edge upon one point and slide into position. They should be adjusted by the screws "E" Fig. 10. When the index goes back to the index plate, the stirrup support

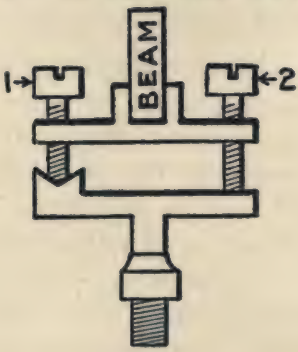

Fig. 11.

should be raised by the front screw "E," Fig. 10, until the knife-edge and plane are parallel. When the index deviates towards the front, away from the index plate, then the stirrups are in opposite positions and adjustment is made by the back screw "E," Fig. 10 until knife-edges and plane are parallel. In balances having upon the beam for a support an adjustment such as Fig. 11, the index deviating back towards the index plate, it is ad-

justed by screwing down screw 1, Fig. 11, and if the index deviated out from the index plate it is adjusted by screwing down screw 2, Fig. 11, until index does not deviate. (This adjustment is not favored by the writer

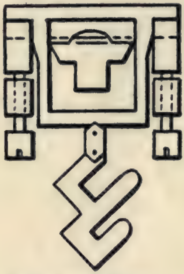

Fig. 12.—Stirrup.

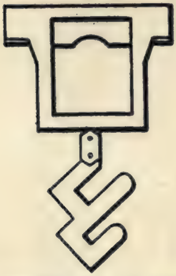

Fig. 12a.—Stirrup and support.

for the reason that it conceals an error that may exist as in Note 5). The distance between the center knife edge and the plane where the beam is supported and the distance between the end knife edges should be equal.

Note 6.—The stirrups, Fig. 12, should balance per-

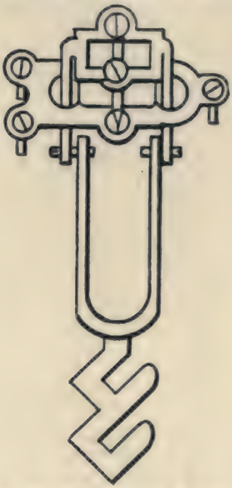

Fig. 12b.—Sartorius stirrup.

Fig. 12c.

fectly upon the knife-edges; that is, first remove the bow from the right hand side, then gently release the beam; if

the lower part of the stirrup or hook swings in towards the pillow, and by tapping the base gently with the hand, the stirrup falls off the knife-edge, the stirrup support, which supports the stirrup, extends out too far. By loosening screw "B," Fig. 10, one screw "C" in front the stirrup support, Fig. 10 can, by a gentle pressure in towards the pillar, be brought to its proper position so that it will balance the stirrup upon the knife edge. If the stirrup swings out from the pillar, then the stirrup sup-

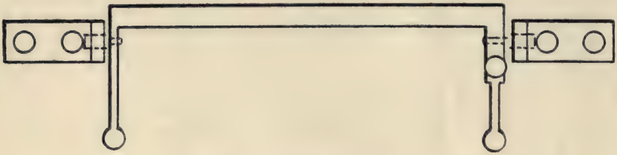

Fig. 13.—Pan arrests.

port must be brought out until the stirrup balances on the knife-edge, then fasten screws "B" and "C." Upon the Sartorius Balance the pillar "C" must be shifted in the place of stirrup support on the Becker and Troemner Balances. Upon releasing a balance, the pan should lightly touch the pan-arrest. If, upon releasing the beam, the index does not remain at the zero point, it is adjusted by the milled head screw upon the right hand side of the pan arrest, or scale-stop. The Becker has only one of these crews, while the Troemner has one on each side.

TO USE A BALANCE WHEN THE ARM LENGTH IS INCORRECT.

A balance of unequal arm length may be used by adding or subtracting the amount of the error, or by changing the theoretical zero point on the index plate. For

Fig. 14.—Bow and pan.

instance: If the arm length is five divisions out either way to the left or right with fifty grms., the index swings out five divisions and back again to the zero point, the

zero point would be two and one-half divisions in the direction in which it swings, and in weighing, that would constitute the theoretical zero point.

RULES TO BE OBSERVED WHEN CLEANING BALANCES.

First.—Remove the bows and stirrups.

Second.—Take hold of the index, or pointer, with the

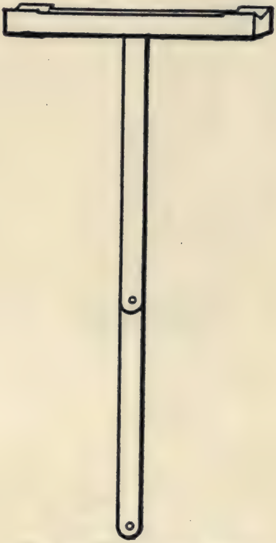

Fig. 15.—T for beam support.

right hand, with a gentle pressure to the right, and turning the key with the left hand, bring the right end of the beam forward and the beam will follow it. Take a clean

cloth and wipe the knife-edges and center and end bearings. Then with a camels hair brush carefully remove all dust from the beam stirrups and other parts, particularly from the planes, as they should always be as free as possible from dust. To replace the beam, lower the beam supports by using the key, and place the socket on the ball; then bring the other end of the beam around until the center knife-edge is over the center bearing. At the same time raise the beam supports. Replace the stirrups and hangers after cleaning and dusting.

Fig. 16.—Key.

Third.—Let the balance stand for about one-half hour, in order to allow the temperature to become uniform.

Fourth.—The friction caused while wiping glass apparatus, such as glass pans, watch glasses, etc., with a cloth for cleaning purposes, electrifies the glass. The charge may be quickly dissipated by gently breathing upon the glass. As a matter of fact this acts instantaneously. The glass should then be placed in the balance and a little time should be allowed for temperature.

THE EFFECT OF AN ELECTRIC LAMP.

Fifth.—Do not place electric lights too close to the top of the balance case, in order to maintain the uniformity of temperature.

When an electric lamp is placed over the top of a balance, so that the heat from the lamp affects the balance—the more powerful rays of heat strike the center of the beam, and naturally the temperature of that part of the beam is higher than the ends, and causes the beam to expand from that point, with the result that, although it may not affect the arm length, it will lower the end knife-edges and reduce the sensibility of the balance. It will be readily seen that repeated changing, in turning on and off the light will in time have its ill effects on the balance, by permanently reducing the sensibility and also effecting the arm length. It is best to have artificial light come from in front of the balance.

Sixth.—Use a little kerosene oil on a cloth with which to clean the case, for it brightens the polish without injuring it.

Seventh.—Do not use sulphuric acid for a drier in a balance having steel knife-edges. If a drier is used, calcium chloride placed in a glass funnel over a beaker, should be used. The moisture passing through the calcium chloride into the beaker. Caustic soda should be used in another beaker in the Balance with the chloride.

Fresh calcium chloride should be added from time to time.

Eighth.—When a balance, after having been thoroughly cleaned, is found to have lost in sensibility, the knife-edges are worn and dull and must be sharpened. They should be attended to at once by a manufacturer or a balance expert.

VIBRATION.

The best results are not obtained from a balance that is subject to vibration. Nearly every laboratory is subject to more or less vibration, but in the laboratories of large concerns this is a particularly trying problem, as they are often improvised in a portion of, or near, a building or buildings containing heavy machinery, or near railroad tracks, etc., which, when operating causes a constant vibration, impairing accurate weighing. This has been made a subject of experiment, and a number of fairly satisfactory methods have been devised for overcoming vibration.

At the United States Metal Company, Grasselli, Ind., holes are drilled in a table top about one-third the depth of a No. 5 rubber stopper. Number five stoppers are inserted into the holes and a piece of lead weighing about 150 pounds measuring a little longer and wider than a balance case is placed upon the stopper. A heavy stone slab or a cast iron block would answer just as well. The

idea, however, is to get as much weight as possible. The balance is placed upon this slab.

At the laboratory of the Bethlehem Steel plant, pillars of iron are embedded in a bed of sand in the basement of the building, the pillars coming up through the floor. A slab is placed upon these pillars, the top of which is about the height of an ordinary balance table from the floor. This has been found very satisfactory where heavy trains are constantly passing the laboratory.

Where the installation of the above mentioned methods are not practical for various reasons, I would advise the following for ordinary purposes. Cut down two No. 5 stoppers about one-third from the top. They must have one hole through the center. Place these under the front set screws of the balance, with the plug of the set screw resting in the hole of the stopper. For the rear post of the balance use a whole stopper. This method proves very satisfactory for ordinary purposes.

THE STAUDINGER BALANCE.

The Staudinger balance, sold by Arthur H. Thomas Co., is so different in construction from the other standard balances in general use, that it requires special adjusting instructions.

The bearings for stirrups and beams are of agate. The front pillars, a, a, a, have a groove for the screw point to

rest into; while the rear pillars have a cone shaped socket for the screw point to rest into. The pillar, a, a, a, must be set so that the groove is in a direct line with the knife-edges; thus, looking from the top, o — - and not, thus, o — |.

The beam should be supported by the two screws in the center knife edge and the two screws f, f Fig. 17 and 18.

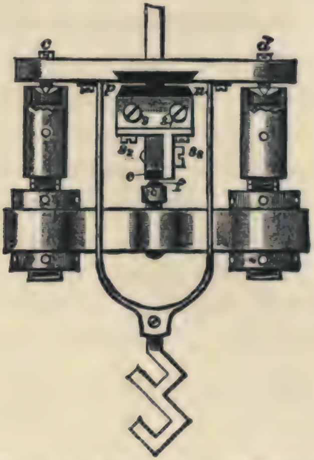

Fig. 17.—Stirrups and stirrup support. Staudinger balance.

When upon releasing the beam on these balances, the index deviates towards or from the index plate, it is adjusted by the screws in the center knife-edges. That is, if the index deviates towards the index plate, the

screw in the front of the center knife-edge must be screwed downward, until the index remains stationary upon releasing the beam; if it deviates from the index plate, the screw in the back of the center knife-edge must be screwed downward. Judgment must be used in either case. If the center knife-edge raises sufficiently from the plane, to allow the opposite screw to be raised, this should be done. That is, if, as in the first case, the

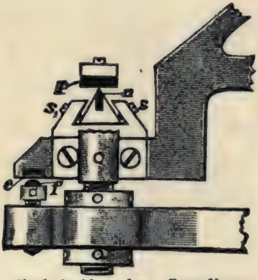

Fig. 18.—End knife edge. Staudinger balance.

index goes towards the index plate, and the knife-edge is sufficiently raised from the plane, to allow the rear screw to be raised, it should be done instead of screwing the front one downward. Also, in the other case, when the index moves from the plate, raise the front screw instead of screwing down the rear one.

When, upon releasing the beam on these balances the index goes to the right or left and back again to the zero point, the trouble is with the stirrups. One of them is

lifting up more from the end knife-edge than the other, and it is adjusted by the screws in the stirrups c, d Fig. 17. The one that raises most should be lowered until it raises no more from the knife-edge than the other. Care must be taken to keep the stirrup plane parallel with the knife-edge.

The pillars should not be used to adjust the stirrups. If the beam does not raise from the center bearing remove the pillar. A screw will be found at the bottom of a rod running through the pillar. Unscrew this screw until the beam raises so that daylight can be seen between the center knife-edge and the plane. The two screws, f, f Fig. 17 and 18, in beam support should lightly touch the beam when beam is arrested.

The adjusting weight for sensibility on this balance is on the back of the center knife-edge and is raised, to raise the sensibility and lowered to reduce the sensibility, but always to correspond with a certain number of divisions upon the index plate, to be determined by placing the rider on the 1 milligram division of the beam.

ASSAY BALANCES.

Because assay balances are used for making the finest weighings, their construction is of the most delicate order. In most cases their adjustments are similar to the adjustments on an analytical balance. Great care

must be exercised in the adjustment of an analytical balance, but even greater care should be taken in the adjustment of an assay balance, particularly in taking the latter apart for cleaning and dusting.

The arm length of an assay balance is more important than the arm length of an analytical balance, but that is not discounting the importance of that feature of the latter balance. This is because there are more direct weighings, of smaller amounts, on the assay balance.

The arm length of an assay balance is tested in the same manner as that of an analytical balance, save only that not more than one grm. is used on each pan of the assay balance.

In the case of later assay balances, sensible to 1/200 of a milligram or less, more than one gram should never be placed in each pan. On some of the older styled assay balances, however, as much as five grams. may be safely placed in each pan.

On account of the extreme delicacy of these balances, only the arm length and sensibility tests should be made, and no other adjustments should be attempted by the user.

TO REPLACE THE GLASS BASE.

In case the glass base, with which some balances are equipped becomes broken, and it would be inconvenient to send the balance to the factory to have the broken base

replaced, the user may replace it himself by exercising particular care in following the rule outlined below. In ordering the new plate be sure to give the *exact* thickness of the broken plate, and the name and the number of the balance, and the date, as nearly as possible, when the balance was purchased from the manufacturer.

To put on a new plate, first remove beam, bows and pans, and stirrups; remove pillar and rider apparatus; take out draw and front and rear frames; draw up the sash cords and tie them together, so as to keep the weights in their proper position in the frame pillar; lay the case flat, and remove the four nuts at the bottom of the case; then replace the Balance in its natural position and then lift off the top part of the case. There are four washers, or there should be, on the top of the cloth where the rods that hold the case together run through. Be sure to replace these washers. Remove all traces of broken glass, dust, etc., from the cloth.

Then screw on the pan arrest supports to the glass base, placing that support with the longest bearing on the screw for pan arrest, on the right hand side. The screws in the pan arrest supports should be in a straight line. See that the bottom of the glass plate is perfectly clean, and the cloth washers in place where the rods run through. Place the plate upon the balance base and put

top of case in position; put the rods through, and screw tightly with the nuts at the bottom of the case, not adding too much pressure, but sufficient to hold the case in place. Replace the pillar, rider apparatus, beam, stirrups and bows and pans. Replace the rear frame.

In putting on a new plate it often happens that the pan arrest plunger appears too long or too short. This may, at times, be regulated by moving the plate backwards or forwards, as the case may necessitate.

If care is taken to give the exact thickness of the plate and the balance number, when ordering the plate from the balance manufacturer or agent, there should be no trouble experienced in putting it on.

WEIGHTS.

KINDS OF WEIGHTS.

The writer has had fourteen years experience in the making and adjusting of analytical and assay weights with one of the foremost manufacturers in this country, besides ten years experience on the road visiting the laboratories of universities and colleges and commercial laboratories. His range of observation has been large and complete, and his opportunity for the careful study of this more than sadly neglected commercial necessity has been equally so. The solution of the weight problem has not been improved upon in fifty years. However, it is not in order to discuss the problem here, and the writer will merely endeavor to outline the best way of utilizing what we have.

He has found that the first quality lacquered brass weights, with the same use and care, retain their constancy longer than the gold or so-called platinum plated weights. Besides the gold or platinum plating on the weights appearing not up to the standard required for this kind of work, he has found also, other causes for concluding that the brass lacquered weight is the best. Such as the use of lead shot in the adjusting of so-called first quality weights. The lead too readily oxidizes, thus changing the original weight. For these reasons he would

recommend the brass lacquered ones for first quality weights for analytical purposes.

CARE OF WEIGHTS.

Ivory pointed or tipped forceps, only, should be used in handling analytical weights. They should never be handled with the fingers; and should be kept as free as possible from all acids and chemicals, likely to corrode them.

The fractional weights should be wiped as frequently as the conditions surrounding them require. The 20 and the two 10 milligram weights, which are often made of aluminum, usually get a trifle heavier after they have been in use for sometime, and require a little more care than do the platinum weights, because they are more readily affected by acids and chemicals.

STANDARD FOR CALIBRATING WEIGHTS.

Without a standard weight, the exact weight of the different denominations of a set of weights cannot be correctly determined. They may be compared with each other, but no positive weights can be deduced by calibrating without a standard.

I would suggest that every laboratory have at least two standard weights, verified by the Bureau of Standards at Washington, D. C. This costs very little, and allows of the proper determination of the exact weight of those that are put to general use. The weights most convenient,

or rather, most desirable, to have standardized or verified are the 100 gram and the 1 gram.

Having these two weights verified, calibration from the 100 gram weight down through the set, or from the 1 gram weight up may readily be done; and the latter may be used in calibrating the fractional weights. The possession of a one gram standard is an advantage in more ways than one. Besides allowing calibrating to both extremes, it is a check upon the 100 gram standard, and vice versa. The latter will be used less however, and will of course, maintain its constancy longer than the one gram. Where the standards are used quite often, they should be verified at Washington at least once a year; but if used only occasionally, once in two or three years is sufficient, where the weight receives especial care.

The standardized weights should never be used in ordinary weighing but only used while calibrating. They should be carefully kept in a covered box.

CALIBRATING WEIGHTS.

Place the larger standard weight in the left hand pan of the balance, and all the weights of the set from and including the 50 grams to and including the 1 gram weights, in the right hand pan, to determine the error, if any, between the standard and the fractional weights. Note the error, if any. Then

remove the standard, placing the 50 gram weight on the left hand side, leaving the remaining fractional weights on the right hand side. Note the error, if any. Then remove the 50 gram weight, placing the 20 gram weight in the left hand pan, and the two 10 only in the right hand pan, removing the other smaller weights. Test them and make note of the error, if any; and proceed by removing one 10 gram weight, and placing the 5-2-2-1 gram weights on the right hand pan with the remaining 10 gram weight, and note error, if any. Then remove the 20 gram weight, and all the weights on the right hand pan, and place one 10 gram weight on the left hand side and the other on the right hand side, and test the two for error. Note, if any. Then place the five grms. weight upon the left hand side and compare it with the two 2 grams and the one gram on the right hand side, and note error. Compare the standard one gram weight with the other, placing the standard on the left hand pan, and note error, if any.

To calibrate the fractional, or milligram, weights, place the standard one gram. weight on the left hand side, and the fractional weights on the right hand side, test and note error, if any. Proceed in the same manner with the milligram weights, down to the one milligram weight, as in the calibration of the gram weights.

In this way compare the errors found to exist with the verified standard one gram weight, and the verified standard weight of 100 grams and thereby determine the exact error in each individual weight, and keep copies of the result of the calibration for use in weighing.

RECIPE FOR LACQUER FOR ALUMINUM, GERMAN SILVER AND BRASS.

Into four ounces of pure grain alcohol put 15 grams of white shellac. Cork well and allow to stand several days. Then carefully pour off the clear solution from the top into a bottle. If necessary put through a filter paper. This makes the best shellac lacquer for German Silver or aluminum.

The same proportion of orange shellac and alcohol makes a lacquer for brass. This lacquer may be used cold or the metal may be heated slightly. Care must be taken, when heating, not to get the metal too hot, as the shellac is likely to blister.

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